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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/871,883	06/01/2001	Birendra N. Agarwala	BUR920000215US1	2063

5409 7590 09/09/2003

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ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 09/09/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 15

Application Number: 09/871,883
Filing Date: June 1, 2001
Appellant(s): AGARWALA ET AL.

Jack P. Friedman
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed June 12, 2003.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant's brief includes a statement that claims 1-4, 6-13,15-20, 22-25, and 27-35 do not stand or fall together and provides reasons as set forth in 37 CFR 1.192(c)(7) and (c)(8).

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

6,376,370 B1	Farrar	4-2002
6,156,651	Havemann	12-2000
6,373,136 B2	Otsuka et al.	4-2002

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-4, 6-13, 15-20, 22-25, 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farrar (US 6,376,370 B1) in view of Havemann (US 6,156,651).

Farrar shows (fig. 3K) an interconnect structure comprising a lower level wire in a dielectric layer having a side and bottom, the lower level wiring comprising a core conductor (307B and 320) and a lower conductive liner (306B and 314). The lower level wire also has integral extensions (part above 307), the extensions having a side and bottom, wherein the lower level wire and extensions also comprise the lower core conductor (320) and the lower conductive liner (314). The liner is formed on the side and bottom of the lower level wire and the extension. The lower conductive liner has an upper edge having an inner surface, an outer surface, and a top surface, the top surface of the upper edge substantially coplanar with a top surface of the dielectric layer. The interconnect also comprises an upper level wire (330) having a side and bottom and a via integrally formed in the bottom of the upper level wire. The via also has a side and bottom. The upper level wire and via comprise an upper core conductor (344) and an upper conductive liner (334), which is formed on the side and bottom of the upper level wire and on the side and bottom of the via. The upper conductive liner on the bottom of the via is in contact with the lower core conductor and also in contact with the lower conductive liner in a liner-to-liner contact region. The lower level wire is formed in a lower level dielectric (302 and 308) and the upper level wire is formed in an upper level dielectric (324). The upper and lower core conductors comprise copper (col. 17, lines 20-39) and the upper and lower conductive liners comprise tantalum nitride (col. 18,

lines 22-33). The lower conductive liner includes an upper edge having an inner surface, an outer surface, and a top surface (top of layer 381 and 382) and the upper conductive line on the bottom of the via contacts one of the top surfaces to form the liner-to-liner contact region. The liner-to-liner contact region also comprises a first portion co-extensive with the lower conductive liner on a portion of a first side (top surface of liner 314) of the lower level wire under the via (see the interface 319 between 383 and 381). The first and second dielectrics consist of silicon oxide (col. 17, lines 39-47). Farrar shows all of the elements of the claims except a portion of the bottom of the upper level wire extending below a top surface of the lower wire level, the upper conductive liner in contact with the inner or outer surface of the upper edge of the conductive liner, and the second and third portions of the liner-to-liner contact region being coextensive with the lower conductive liner. Havemann shows (fig. 3G) an interconnect structure in which a lower level wire has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has an upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region. A portion of the bottom of the upper level wire extends below a top surface of the lower wire level. The upper conductive liner is in contact the lower core conductor and also in contact with the inner surface of the outer surface or both surfaces of the upper edge of the conductive liner (see how the upper liner 48 overlaps the upper edge and sides of lower liner 36). The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a

third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire. With this configuration, the interconnect can be formed without mechanical defects (abstract). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the liner-to-liner contact region of Farrar by adding the second and third coextensive portions as taught by Havemann to form a contact without mechanical defects.

With respect to the limitations concerning the damascene process of forming the wires, a "product by process" claim is directed to the product per se, no matter how actually made, In re Hirao, **190 USPQ 15 at 17**(footnote 3). See also in re Brown, **173 USPQ 685**: In re Luck, **177 USPQ 523**; In re Fessmann, **180 USPQ 324**: In re Avery, **186 USPQ 116** in re Wertheim, **191 USPQ 90** (**209 USPQ 254** does not deal with this issue); and In re Marosi et al, **218 USPQ 289** final product per se which must be determined in a "product by, all of" claim, and not the patentability of the process, and that an old or obvious product, whether claimed in "product by process" claims or not. Note that Applicant has the burden of proof in such cases, as the above case law makes clear. "Even though product-by- process claims are limited by and defined by the process, determination of patentability is based upon the product itself. The patentability of a product does not depend on its method of production. If the product in product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product is made by a different process." In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985)(citations omitted).

Claims 30-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,373,136 B2).

Farrar shows (fig. 3K) an interconnect structure comprising a lower level wire having a side and bottom, the lower level wiring comprising a core conductor (307B and 320) and a lower conductive liner (306B and 314). The liner is formed on the side and bottom of the lower level wire. The interconnect also comprises an upper level wire (330) having a side and bottom and a via integrally formed in the bottom of the upper level wire. The via also has a side and bottom. The upper level wire and via comprise an upper core conductor (344) and an upper conductive liner (334), which is formed on the side and bottom of the upper level wire and on the side and bottom of the via. The upper conductive liner on the bottom of the via is in contact with the lower core conductor and also in contact with the lower conductive liner in a liner-to-liner contact region. The lower level wire is formed in a lower level dielectric (302 and 308) and the upper level wire is formed in an upper level dielectric (324). Farrar shows all of the elements of the claims except the dielectric pillars formed in the lower level wire. Otsuka et al. discloses (col. 12, lines 30-52) insulating pillars formed in a level of wiring. With such a configuration a highly reliable damascene structure is formed (col. 2, lines 50-52). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the lower interconnect wiring level of Farrar by adding dielectric pillars as taught by Otsuka et al. to form a highly reliable damascene wiring structure.

Claims 34 and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farrar (US 6,376,370 B1) in view of Otsuka et al. (US 6,373,136 B2) as applied to claims 31 and 33 above, and further in view of Havemann (US 6,156,651).

Farrar and Otsuka et al. show all of the elements of the claims except the second and third portions of the liner-to-liner contact region being coextensive with the lower conductive liner. Havemann shows (fig. 3G) an interconnect structure in which a lower level wire has a lower core conductor (39) and a lower conductive liner (36). An upper level wire has a upper core conductor (52) and an upper liner (48), in which the upper liner is in contact with the lower liner to form a liner-to-liner contact region. The liner-to-liner contact region also comprises a second portion (overlap portion of liner 48) co-extensive with the lower liner on a portion of a second side (outer portion of liner 36) of the lower level wire and a third portion (overlap portion of liner 48 in the hole) co-extensive with the lower conductive liner on an end (inner portion of the liner 36) of the lower level wire, each portion being under the upper level wire. With this configuration, the interconnect can be formed without mechanical defects (abstract). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the liner-to-liner contact region of Farrar and Otsuka by adding the second and third coextensive portions as taught by Havemann to form a contact without mechanical defects.

(11) Response to Argument

Although the Appeal Brief is lengthy, only a few primary arguments are presented. Specifically, the appellant repeatedly argues that Farrar and Havemann do not show a "portion of the bottom of said upper level wire extending below a top surface of the lower wire level" and that the motivation for using Havemann is improper. The appellant also argues that Farrar combined with Otsuka does not show all of the elements of the claims. The examiner believes that the prior art references show all of the elements of the claims and that the motivation for combining has been explicitly taught.

With respect to the argument that Farrar and Havemann do not show all of the elements of the claims, the examiner still contends that the cited references teach every element. The appellant primarily argues that a "a portion of the bottom of the upper level wire extends below a top surface of the lower wire level" has not been taught by the references. Other variations of the same argument state that the references also do not teach that "said liner-to-liner contact region further comprises a second portion co-extensive with the lower conductive liner on a portion of a second side of the lower level wire under said via." The phrases in question each pertain to how the upper conductive liner (270) is formed over the lower core conductor (200) and lower conductive liner (215 or 285) to provide an overlap portion (see figure 4A). The appellant repeatedly makes the same argument for different phrases that generally state the same limitation. Therefore the examiner will rebut the one argument that Havemann does not disclose the specific liner-to-liner contact region in which a portion of the bottom of the upper

level wire extends below a top surface of the lower level wire. As stated in the rejection above, Farrar (fig. 3k) was cited to show a lower conductor (307A), a lower conductive liner (306A), and an upper core conductor within upper conductive liner (314). Farrar did not show that the upper level conductor extended below a top surface of the lower level conductor. Havemann was cited to cure the deficiency by showing (fig. 3F) that an upper conductor structure (via containing 52 and 48) extends below a top surface of lower conductor level (36 and 39). The upper via of Havemann forms a liner-to-liner contact region between upper liner (48) and lower liner (36). The applicant argues that the upper liner (48) of Havemann cannot be conductive because it is listed as a silicon nitride (col. 4, lines 65-67). The examiner believes that the liner (48) may be conductive because the purpose of forming the upper level is to be a conductor groove (col. 4, lines 55-64). If the groove is to be conductive then everything within it must be conductive including the liner (48) and the core (52). Furthermore, Havemann calls liner (48) an encapsulation layer in the same way lower liner (36) is labeled a via encapsulation layer (col. 4, lines 37-40) having titanium nitride, which is known to be conductive. It seems that if liner layer (48) is non-conductive, then the via which it forms cannot make electrical contact with the lower via. Although silicon nitride is listed only as an example of the upper liner layer (48) there is nothing else in the text of Havemann to indicate that the layer is non-conductive. Therefore, it is assumed that upper liner layer is conductive and forms the appropriate liner-to-liner contact region as stated in the claims. Even if the upper liner (48) of Havemann were non-conductive, Farrar already discloses an upper liner of conductive material. One would only look to Havemann to obtain the

structure of the liner-to-liner contact region or a portion of the upper level conductor extending below a top surface of the lower level conductor. Havemann discloses that such a configuration forms vias without deleterious mechanical effects (last line of the abstract).

With respect to the appellant's argument that the motivation to combine (which was taken from Havemann) is improper, the examiner believes that the motivation is proper and that the appellant's interpretation of the language is incorrect. The appellant continuously harps on the fact that the examiner stated that a "contact is formed without mechanical defects." The appellant then pointed out the Havemann only states that "Methods are shown for realizing desirable insulating and conducting layers without deleterious mechanical effects." It is true that the examiner took the liberty of paraphrasing the statement in the last line of Havemann's abstract, however the meaning of both phrases are the same. The meaning of "deleterious" taken from Merriam Webster's Collegiate Dictionary (10^{th} Edition) is "harmful often in a subtle or unexpected way." Therefore, if one were to understand the meaning of the phrase "without deleterious mechanical effects" if would be understood to mean "without harmful mechanical effects." Loosely interpreted, that statement means that the structure is formed without mechanical defects. Even if one were not to interpret that statement in such a way, one would still gather motivation from the phrase by realizing that the structure is a desirable contact without harmful mechanical effects. In essence, the appellant's argument is irrelevant because motivation has been taught in the Havemann reference.

With respect to the final argument that Farrar and Otsuka do not show all of the elements of the claims, the examiner believes that Otsuka cures the deficiency of Farrar and shows motivation for combining. Farrar, disclosing the various wiring levels each having conductive cores and liners, was only deficient in disclosing dielectric pillars formed in the wiring lower level. Otsuka was cited to show that dielectric pillars were formed in a wiring level to improve the structural integrity. Since ~~a~~ semiconductors often have many wiring levels, and each wiring level essentially consists of the same structures, one of ordinary skill would find that the dielectric pillars of Otsuka's wiring level would be also useful in a lower wiring level. Furthermore, as seen in figure 13C of Otsuka, the dielectric pillars (P) are formed next to conductive wiring material (10). Therefore one of ordinary skill in the art, wishing to improve the structural integrity of the lower wiring level would add the dielectric pillars of Otsuka and form them next to the wiring levels having a core and a liner of Farrar. Therefore, Otsuka cures the deficiency of Farrar and shows motivation for the improvement.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

MEW

September 2, 2003

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